An Interactive Report Generator for Bone Scan Studies

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Abstract

An interactive report generator for bone scintigraphy will be demonstrated. It comprises a controlled reporting vocabulary, an adaptive user interface, and a text generator. The controlled vocabulary represents the relevant concepts for bone scan reports: anatomical sites, scintigraphical phenomena, and diagnoses, and various attributes for these concept domains. Within the vocabulary selectional constraints are defined that restricts to meaningful combination of concepts. The interface provides intelligent views on the vocabulary, and presents only those terms that are relevant in a certain context. Through the interface the user may choose appropriate terms and combine them to complex findings. A German text generator for a restricted finding language transforms the entered data into morpho-syntactic surface structures and produces acceptable reports.

Introduction

At most places routine bone scan reports are dictated and typed or handwritten. This may lead to illegible reports, intolerable time delays, and uncomparable findings impeding quality control. Computerized support for report generation based on canned texts or templates fails, because of the variety and detail of conceivable observation types and the combinatory explosion of text units to be provided. These methods may be successful in narrow domains with a small number of finding types. But, in bone scintigraphy every part of the human skeleton is of possible interest, the pattern of tracer uptake may show different characteristics, and the relevant diagnoses for the field refer to the full spectrum of bone and joint diseases.

The system to be demonstrated is an interactive report generator for a diagnostic imaging procedure that integrates text generation facilities. It consists of a database with a controlled reporting vocabulary, an adaptive user interface and a German text generator. The vocabulary database contains the relevant anatomical concepts, scintigraphic findings and diagnoses as well as attributing concepts of various types. The interface provides intelligent views on the vocabulary and presents only those terms that make sense in a particular context. The interface allows the user to assemble complex findings only by term selection and combination. The text generator produces acceptable German reports from the entered data.

Controlled Vocabulary

The controlled vocabulary is the core of the system. It defines a restricted clinical sublanguage for bone scan reporting. There is a finite set of concepts that determine the degree of detail provided for expressing observations. These concepts have been identified by protocol analysis and expert interviews and are organized in a class hierarchy (Fig.1,[1,2]). The vocabulary provides concept classes for types of abnormal tracer uptake, disease categories, bones joints and soft tissue organs, and attribute types for pathological entities and body sites. There are additional concept domains for the type of patient problem, i.e. confirmation, follow-up etc. of a disease process, and for technical modalities of the procedure. Finally, there are concept domains that refer to complex text fragments which are not deeper represented. These concern diagnostic and therapeutic recommendations. At present the vocabulary contains about 400 anatomical concepts, 150 concepts for observations and diagnoses, 120 attributes and 50 composite texts or text fragments.

In order to make the vocabulary generative, concepts can be combined to form structured propositions. However, not every combination of terms from the controlled vocabulary is meaningful. In order to rule out senseless combinations, the vocabulary is constraint. That means, the relations between particular concept domains are restricted by selectional constraints. The definition of the constraints makes use of the concept hierarchy which supports their inheritance from supertypes to subtypes and parts[1].

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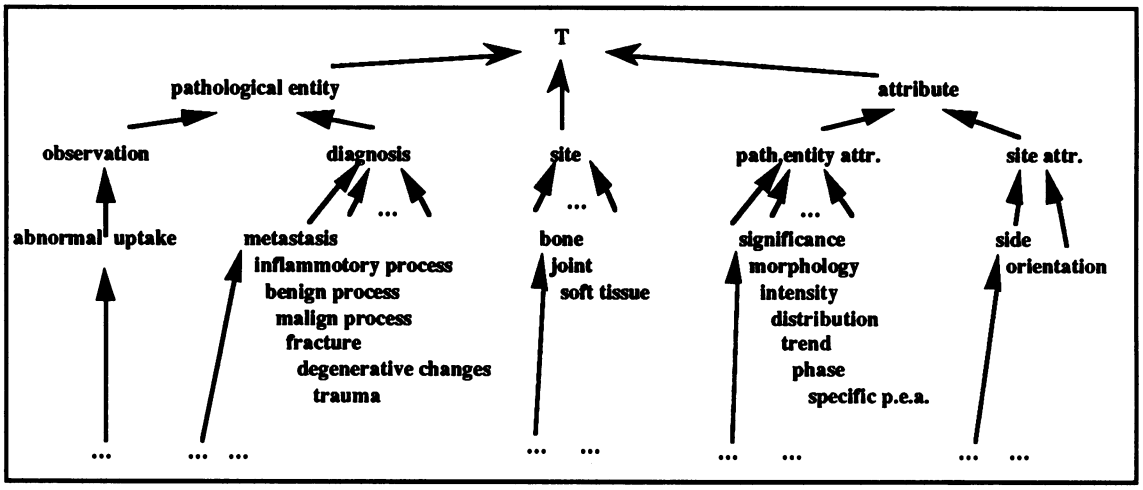

Figure 1: The concept type hierarchy of the reporting vocabulary.

Adaptive Interface and Text Generation

The vocabulary is presented to the user through an adaptive graphical interface, from which he may choose appropriate combinations [3]. Figure 2 shows the input screen for findings. In the upper section (A) the user may specify the uptake pattern and the affected anatomical sites. The second section (B) is for the input of interpretations. Anatomical and diagnostic concepts are refinable. Section (C) is for side findings concerning soft-tissue organs and recommendations, and (D) is a short cut list of the user's input. For report generation complex findings can be assembled and entered only by mouseclick.

The internal representation of findings is based on a conceptual graph model [1,4]. This model serves as the platform for storing and verbalizing findings. The design of the database schema is orientated to the generalized model described in [5]. This schema holds the conceptual primitives of findings in a nested way. For generating reports a German text generator for a restricted finding sublanguage has been implemented. It transforms abstract representations into morpho-syntactic surface structures. Since German is a language rich of inflections and composite word forms, dictionaries are provided for substantives, adjectives, adverbs, propositions, and verb forms. These dictionaries represent inflection types, and singular and plural roots for nouns, cases and article types for prepostions, and conjugation types and information about the usage of auxilliary verbs for verbforms. Every term of the controlled vocabulary is linked to the dictionary for every word component. The text generator considers the focus concepts of findings, the order of treatment of conceptual relations, and is able to make decisions about the realization of elisions. The generated texts resemble the telegraphic style of routine clinical reporting. Noun phrases and prepositional phrases are prevailing. Verb phrases are used only if unavoidable. An example of a report generated by the system is given in Figure 3.

Realization

The system has been realized with 4th Dimension [6], an integrated database system, as carrier and runs on a Macintosh II.

References

[1] Bernauer J., Conceptual graphs as an operational model for descriptive findings, Proc. 15th Symposium on Computer Applications in Medical Care, Washington DC,1991

[2] Bernauer J, A controlled vocabulary framework for report generation in bone-scintigraphy, in Miller RA (ed.): Proc. 14th Symposium on Computer Applications in Medical Care, Washington DC,1990, IEEE Computer Society Press, 1990, pp 195-199

[3] Bernauer J., Designing a Terminology Controlled Interface for Report Generation, in Timmers T., Blum B.I. (eds.), Software Engineering in Medical Informatics, North Holland, 1991 (in press)

[4] Sowa J.F., Conceptual Structures, Addison Wesley, 1984

[5] Friedman C., Hripcsak G., Johnson S.B., Cimino J.J., Clayton P.D., A Generalized Relational Schema for an Integrated Clinical Patient Database, in Miller R.A.(ed.): Proc. 14th Symposium on Computer Applications in Medical Care, Washington DC,1990, IEEE Computer Society Press, 1990, pp 335-339

[6] 4th Dimension, ACI

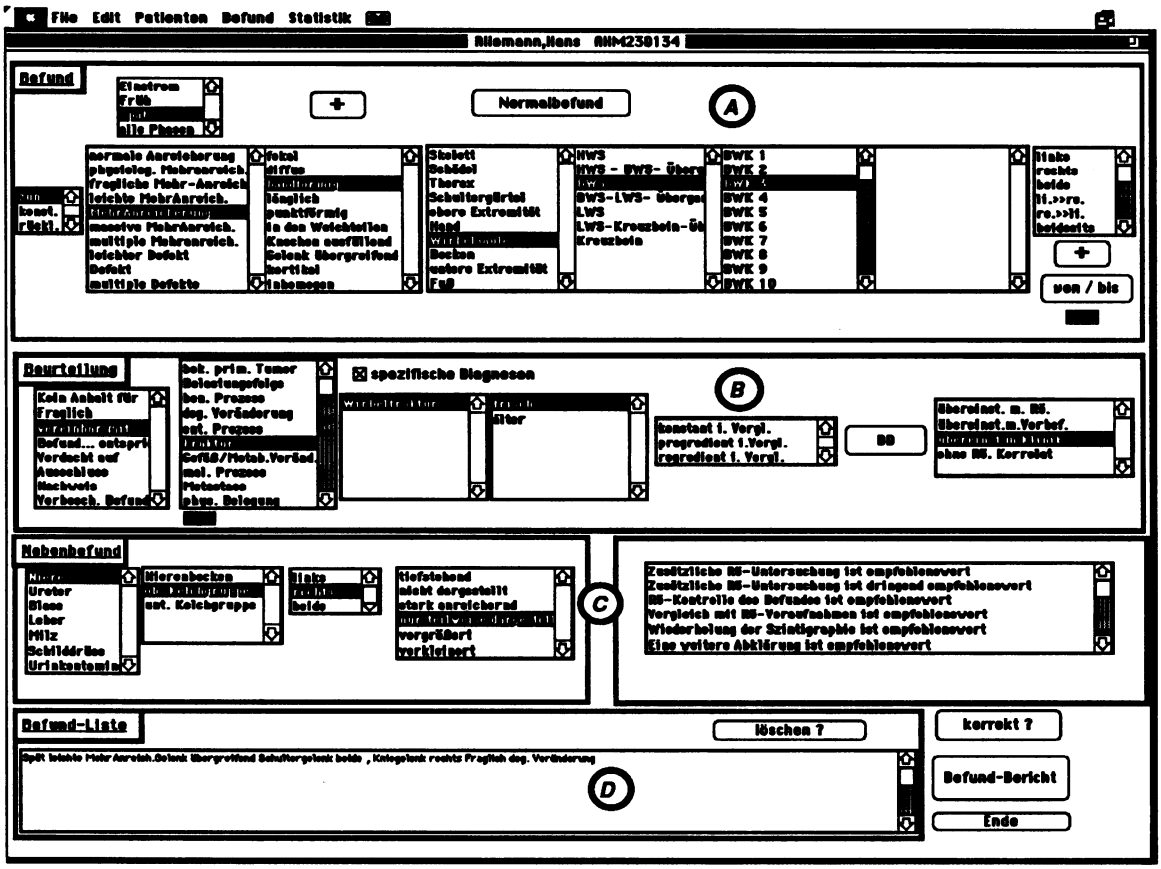

Figure 2: The interface of the report generator for the input of findings.

Fragestellung Schmerzen im Bereich der Wirbelsäule,
Verdacht auf Wirbelfraktur im Bereich der BWS

Technik 3-Phasen Skelett-Szintigramm mit 740 MBq 99mTc-MDP i.v.

Befund:

In der Spät-Phase zunehmende bandförmige Mehranreicherung vom 3. BWK bis zum 5. BWK.
Leichte gelenkübergreifende Mehranreicherungen an beiden Schultergelenken und im Bereich des rechten Kniegelenkes.

Beurteilung:

Befund vom 3. BWK bis zum 5. BWK in Übereinstimmung mit der Klinik vereinbar mit frischer Wirbelfraktur.
Fragliche degenerative Veränderungen an beiden Schultergelenken und im Bereich des rechten Kniegelenkes.

Nebenbefund: Obere Kelchgruppe der Niere, rechts, nur teilweise dargestellt. Eine weitere Abklärung ist empfehlenswert.

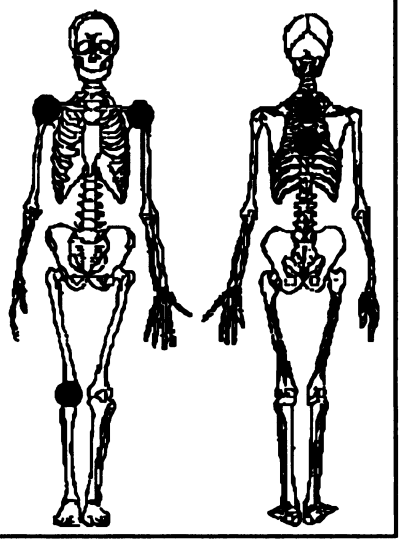

Figure 3: An example report generated by the system